OE Visualization and Controls Peer Review

Overview of Reliability and Markets

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Reliability and Markets

- Focus: Develop a comprehensive set of integrated market/engineering design principles and tools for a restructured electricity business.

- Program Goal: By 2010, design, perform, and interpret market simulations that test regional transmission organization's (RTO) electric market designs prior to full scale implementation, and assist Federal, State, and RTO decision makers in establishing electricity market designs.

- Next Steps: Development of next generation integrated market/system planning and operation tools. Integrate renewables and the environment into the tools and market design.

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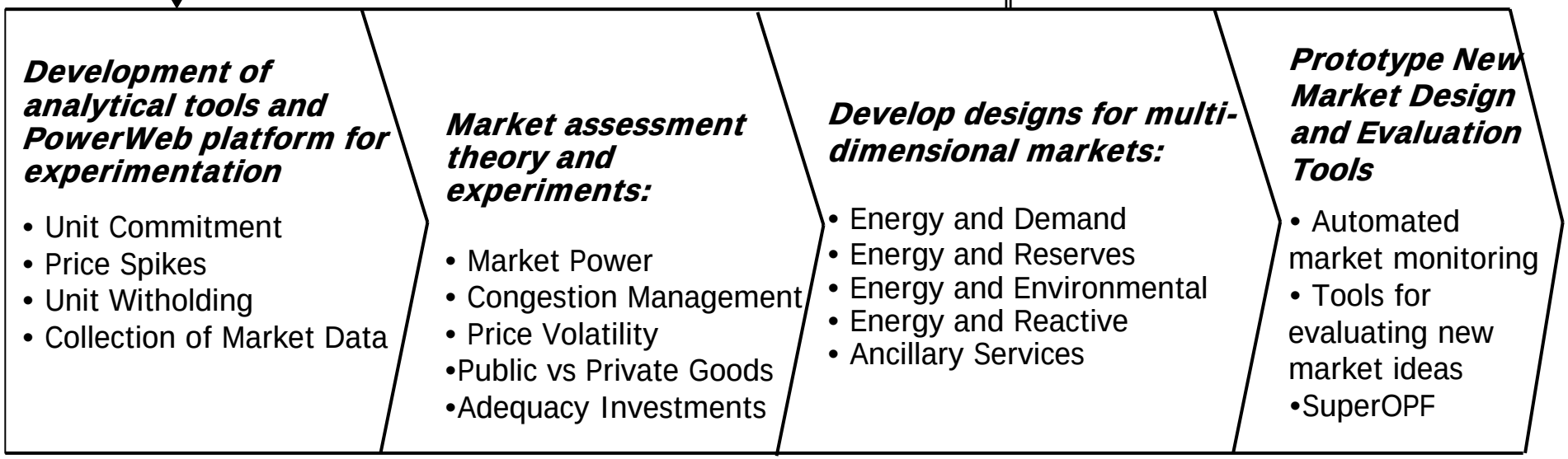
Reliability and Markets - Roadmap

System Planning
Operation and
Monitoring

GOAL: INTEGRATED MARKET DESIGN:
THEORY, EXPERIMENTS AND TOOLS

Advanced Design and Monitoring Tools



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Reliability and Markets

Objective:

Support fair market operation while ensuring potential service suppliers have the proper information and adequate incentives to maintain reliability.

Approach:

- Develop technologies to enable customer participation in providing reliability resources
- Develop market simulation tools to guide decision-making by system operators
- Assess effectiveness of emerging market mechanisms to meet reliability needs

FY 2006 Projects

Multidimensional Market Design

Project 1A - Coordination and planning for the efficient transfer of power across control areas

Lead - Dick Schuler, Others -Tim Mount, Duane Chapman, Shmuel Oren, Bill Schulze

Project 1B - Designing and testing markets for real and reactive power

– Lead Bob Thomas Others - Tim Mount, Bill Schulze

Project 1C: Experimental Lab Program Support

Lead – Ray Zimmerman, Others - Carlos Sanchez, Harry Wang, Bob Thomas, Tim Mount

Market Monitoring Tools

Project 2A: Sensitivity-based metrics

Lead – Bernie Lesieutre Others - Bob Thomas, HyungSeon Oh

Resource Adequacy

Project 3A: Long-term Planning and Investments for Transmission and Generation

Lead: Tim Mount Others - Fernando Alvarado

Today's Program

Bernie Lesieutre, Bill Schulze and Tim Mount are here to talk about projects 1B, 2A and 3A

I want to talk briefly about the lab support program

Lab Support Program

- Lab support is primarily Ray Zimmerman
- Substantially about providing tools for R&M experimental testing
  - PowerWeb - overall web-based power market simulation & testing platform
  - MATPOWER - underlying AC OPF based market solver
- In 2006 supported market tests & pilots related to
  - Seams
  - Reactive power markets
- In 2006 we began the work needed to extend PowerWeb and MATPOWER with a flexible, robust

“Super OPF”

Super OPF

Set of tools that, optimally dispatch and correctly price:

Real energy
VArs
Real power reserves
Dynamic reactive reserves
Voltage

- Subject to:
  - Current operating conditions (load, network topology, scheduled & unplanned outages, etc.)
  - Set of bids & offers for various services
  - Explicit set of credible contingencies (no proxies)
  - Locational nature of reliability requirements & available resources
  - Consistency through various time horizons (planning, day-ahead, real-time, etc.)

CURRENT AC OPF'S

- Not Widely Used
- Do not take explicit account of contingencies (they are evaluated afterwards)
- Not compatible with market design (reactive, voltage, etc.)

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Super OPF Features

In this formulation:

- Reserves are locationally optimal.
- Contingencies constrain the dispatch explicitly.
- Cost of reliability is optimized explicitly.

We call this a co-optimization framework into which we can build correctly priced real-time market products and adequacy/operational reliability requirements

SuperOPF is a Co-optimized, Contingency Constrained Secure OPF (CCC-SOPF)

CCC-SOPF Formulation

- Basic idea [1]:
  - Given a base configuration and *k* post-contingency configurations, treat each one as a separate island in a single large network.
  - Formulate an OPF to solve this unified system, where the dispatches in the "islands" are tied together via additional ramp-constrained reserve variables, and the costs are probability weighted [2].

[1] Carlos Murillo, 2001
[2] Jie Chen, 2003

Full CCC-SOPF Formulation

To standard OPF formulation:

- Add probability weighted (inc/dec) costs on deviations of contingency dispatch from base contracted dispatch.
  - e.g. useful for solving balancing market
- Add costs on maximum deviations from base contracted dispatch (reserve costs).
  - incremental and decremental
- Identical setup for reactive power
  - Includes locationally optimal dynamic reactive reserves
- Use improved interior point solver, based on Harry Wang's thesis work, in progress
  - Improved performance and scalability
  - Improved robustness

CCC-SOPF Status

- Initial implementation complete
- Recently began preliminary testing

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Variations of CCC-SOPF

- Problem: Must maintain a consistent approach as new information becomes available.
  - Some involve simple updates to the data in the same formulation
    - Load forecasts
    - Outages
    - List of credible contingencies, contingency probabilities
  - Others involve a change in problem formulation
    - Reserve contracts signed
      - Reserve variables replaced by fixed limits
    - Day-ahead energy contracts signed
      - Reference for inc/dec quantities is fixed
    - Post-contingency
      - Re-introduce reserve variables to contract for additional reserves

Status of Variations

- Working on problem formulations.
- Preliminary testing of prototype implementations.
- Determining most appropriate prices to use for each problem formulation.